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STUDIES ON THE BIOLOGY OF TRIATOMA SANGUISUGA (LECONTE) IN KANSAS, (REDUVIIDAE, HEMIPTERA)*[1]

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This is an account of the bionomics of **Triatoma sanguisuga** (LeConte) based upon observations made in connection with studies in Kansas upon the transmission and reservoir of the virus of equine encephalomyelitis. It was discovered by Kitselman and Grundmann (1940) that this insect occurred in a naturally infected condition in the pastures and hillsides about Manhattan, Kansas. In order to more fully understand the relationship of **Triatoma** to this important neurotropic virus disease of man and the horse, and to aid in estimating its importance as reservoir and vector, it was found necessary to acquire additional knowledge concerning the life cycle and habits of this hematophagous species in the area.

Originally described by LeConte (1855) from Georgia and South Carolina, the species ranges as far north as southern Illinois, and from the Atlantic seaboard to Arizona, covering the entire southern part of the United States. It is also found in Mexico along the western seaboard to the latitude of the tip of lower California. A complete record of its range is reported by Usinger (1944).

Early references to the biology of **T. sanguisuga** are mostly in regard to its bloodsucking habits. LeConte (1855) reported that the insect could inflict a painful bite and was remarkable because it sucked the blood of mammals, preferring children in particular. Walsh and Riley (1869) also gained evidence that the insect was a seeker of human blood. Kimball (1894) stated that the insect was often found in her home and that it had increased in such numbers in the region of Manhattan, Kansas, that it was considered a common insect. She also observed the adults flying into stables and hen houses and feeding upon horses and chickens. Readio (1927) has summarized published work prior to his publication and reports Morrill as stating that in many parts of Arizona, **Triatoma** species have taken the place of the common bedbug as a household pest. More recent notes upon the distribution and habits may be found in publications by Wood (1940) and Usinger (1944).

Within the last few years, this species has been shown to be a potential menace to health. In addition to being naturally infected with western

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[1]This paper is an outgrowth of a study of the relationship of arthropods to equine encephalomyelitis at Kansas State College, which was financed in part by a grant from the Horse and Mule Associaiton of America. The facilities of the School of Veterinary Medicine and of the Department of Entomology of the Kansas State College of Agriculture and Applied Science were used in this study. The project was conducted under the supervision of Dr. Roger C. Smith, head, Department of Entomology, Dr. L. M. Roderick, head, Department of Veterinary Pathology, and Dr. C. H. Kitselman, Pathologist, Kansas Agricultural Experiment Station.

strain equine encephalomyelitis, it has been reported to be naturally infected with **Trypanosoma cruzi** of Chagas Disease as reported by Davis, McGregor and de Shazo (1943).

APPARATUS AND TECHNIQUE

Apparatus was developed for two purposes: First, to maintain cultures of the insect in the laboratory, and second, to maintain individual insects for life cycle observations. The apparatus developed for the first purpose consisted of two cages, a smaller one placed inside a larger. The larger cage was 18x18x24 inches and was constructed of wood and screen with one side removable as a tight fitting door. The inner, and smaller, cage containing the host animal used to provide blood for the colony was made up of two office letter baskets wired together hinge-fashion at one side with a wire fastening on the other side. The animal cage was held above the floor of the larger cage by being placed upon blocks of wood. Paper toweling placed beneath the animal cage caught the feces and absorbed the urine. In an attempt to simulate natural conditions, trash of various types, such as paper, sticks, stones etc., was placed in the outer cage to provide concealment for the specimens. The cages were kept darkened and a guinea pig or wood rat was placed in the inner cage overnight once every five days to provide the necessary blood. Moisture was provided by placing a moist piece of absorbent cotton in the cages daily.

Small ant cages and large vials served as containers used in the second or life cycle experiments. The ant cages obtained from Ward's Biological Supply were very good as they have a darkened section with excellent possibilities of observations. When vials were used, strips of paper toweling were included to give the insects something upon which to cling and to absorb excreta. Small pledgets of cotton were moistened daily and placed in the vials, since it was found that in case moisture was insufficient, molting would not be normal and the insect would be unable to cast completely the exuviae which usually proved fatal. Individual specimens were placed in contact with an animal overnight in the apparatus described for maintaining cultures in the laboratory.

When insects were fed upon horses, a screen cage was used which could be fastened to the shaven side of the animal with adhesive tape. Four or five specimens of different instars were allowed to feed at the same time. When monkeys were used, a cage was constructed which contained a false bottom. The specimens to be fed were placed in the bottom section which contained holes one-half inch in diameter to allow the specimens access to the cage containing the monkey.

The principal animals used for feeding purposes in the laboratory were guinea pigs and wood rats. In addition, horses and a rhesus monkey were used in a number of trials. Insects fed upon the blood of one animal did not hesitate to engorge when placed upon an animal of a different species for the next feeding, nor did the blood of the various species in subsequent feedings appear to affect development.

FIELD OBSERVATIONS

The natural host of **T. sanguisuga** in the region of Manhattan was found to be the wood rat, **Neotoma floridana baileyi** Merriam, and it was from the nests of this species that the majority of the specimens collected were taken. On several occasions, specimens were also taken from the nests of the western cotton rat, **Sigmodon hispidus texianus** (Audubon and Backman). The insect also feeds upon other animals in its environment, since a few of the specimens were collected at a distance from rodent burrows. On one occasion, three nymphs examined for virus were found to be engorged with a clear yellowish fluid resembling blood serum, possibly insect blood.

The wood rat host was found to build its burrows beneath the flat stones along the limestone outcrops protruding from many of the hillside pastures of eastern Kansas and abundant in the area about Manhattan. Outcrops near bushy and woody areas were found to be preferred by the rats since these localities provide more abundant food than the open grassy areas. In the valley bottoms, especially wooded sections where suitable stones were absent, the rat nests were built of detritus and sticks. Few of the latter type nests were found that were not built within a bush or about the base of a small tree, since some supporting structure is needed to keep the nest from easily being disturbed. Nests were also found in wood piles on the farms.

Most of the specimens taken were collected from nests built beneath loose stones along the limestone outcrops. These nests could be easily located by the sticks and detritus which the rats pile on top of the overlying stone and about the entrance to the nest beneath the stone. When the overlying stone was overturned, adults and nymphs could be found clinging to the underside or in the cracks and crevices of the stone, and in the detritus and small rocks within a yard of the inner nest of the rat. The insects apparently select resting positions that are well protected from the host.

The nests most commonly selected by the insects were those providing a more or less constant micro-climate and remaining dry throughout the year. The nests most heavily parasitized were those in which the overlying rock was found to rest upon a series of broken rock or talus as in an eroded bedding plane. This type provides a multitude of dry cracks and crevices into which the **Triatoma** could retreat while digesting their meals. Stones allowing water to drain beneath them during wet weather or embedded in the soil of the hillside were not selected by either the rats or the insects.

When the flat, overlying stones were overturned, many of the insects could be found clinging to the underside. The position, with the ventral side uppermost, seems to be preferred while the insects are digesting their meals. It was also prevalent in the laboratory colonies where they could hang on the underside of the animal cage, and other detritus provided for their concealment. The nymphs appear to be negatively phototropic at all times. The adults, become positively phototropic soon after molting and may be collected about lights in the vicinity. After fertilization, the adults find a host and do not use their wings again.

The insects were found to hibernate during the cold portions of the year. There is no diapause, since field observation showed them to become sluggishly active during warm winter days. Some nymphs appeared to overwinter in a partially engorged condition. During hibernation the insects assume a dorso-ventral position.

The results of the collections of **T. sanguisuga** are summarized in Table I. Specimens were sent to H. G. Barbour of the Bureau of Insect Identification and to Dr. A. Packchanian of the United States Public Health Service for verification, and to the latter for examination for infection with **Trypanosoma cruzi**. A total of 375 specimens were collected during the sur-

Table I. Summary of **Triatoma sanguisuga** collected for experimental purposes in the vicinity of Manhattan, Kansas, from May, 1940 to November, 1941.

	Instar.											
Date	1	2	3	4	5	6	7	8	M	F	*	**
May 12, 1940	....	....	....	....	4	1	4	....	2	3	14	28
May 28, 1940	....	....	....	2	....	5	7	....	2	2	17	28
June 11, 1940	....	....	....	4	5	....	3	3	1	3	19	26.3
June 21, 1940	....	....	....	....	....	3	4	....	3	4	14	28.5
June 28, 1940	....	2	1	4	3	1	3	....	....	1	15	40
Aug. 10, 1940	....	3	4	....	....	....	....	5	2	4	18	22.2
Nov. 29, 1940	....	....	1	1	1	1	8	....	2	....	14	14.2
Jan. 11, 1941	....	2	4	6	4	3	4	2	....	....	25	4
Feb. 17, 1941	....	....	....	....	....	....	....	1	1	1	3	0
Mar. 11, 1941	....	....	....	....	....	....	....	....	....	....	0	0
Apr. 10, 1941	....	....	....	1	....	....	1	....	....	....	2	0
Apr. 11, 1941	....	....	....	....	....	....	....	....	1	....	1	0
Apr. 12, 1941	....	....	1	....	1	....	....	....	....	....	2	0
Apr. 17, 1941	....	....	....	1	....	....	....	1	....	....	2	0
Apr. 22, 1941	....	3	4	1	....	1	2	....	....	....	11	20
Apr. 24, 1941	....	3	3	1	4	4	2	6	....	....	23	43.4
May 6, 1941	....	2	1	....	....	1	2	....	....	....	6	16.6
May 8, 1941	....	1	2	3	3	5	5	2	....	....	21	38
May 13, 1941	....	6	4	5	4	7	9	7	1	1	44	47.7
June 5, 1941	2	6	3	3	2	4	3	4	1	3	31	37
July 8, 1941	1	....	3	2	5	1	....	3	1	2	18	22
Sept. 11, 1941	1	5	4	3	3	3	5	7	1	3	35	18.1
Oct. 13, 1941	1	5	4	1	1	5	3	1	1	....	22	14.2
Nov. 11, 1941	....	8	2	1	....	2	....	3	....	....	18	16.6
Totals	5	46	41	39	40	47	65	45	19	27	375	

*Total number insects collected.

**Percent naturally engorged.

vey, which covered a period of eighteen months. A more or less equal distribution was noted among the various instars, with the exception of the first instar, a number of which were probably overlooked, and the adults, some of which had migrated previously.

Some wood rat nests were very heavily infested while some were entirely free from parasites. One nest investigated contained 23 **Triatoma** of various instars, 77 **Ornithodoros turicata** Duges and seven fleas, **Epitedia wenmanni** (Roths).

LABORATORY OBSERVATIONS

Life Cycle Studies. The egg of **T. sanguisuga** is about 1.5 mm. in length, oval, and pearly-white in color. There is an operculum at one end which is forced off during eclosion. The embryo is encased in its embryonic membrane, from which it emerges, leaving the membrane attached to the shell. The eggs are deposited singly and indiscriminately without apparent regard for micro-climate. There is no adhesive material to fasten them to a surface. In nature, the eggs, are deposited while the female is quiescently digesting the blood meal.

Temperature was found to have an effect upon both oviposition and embryonic development. One to three eggs were deposited daily when the mean daily temperature was below 80 degrees F. and three to five daily when above. Embryonic development was accelerated by increased temperatures and retarded by lowered temperatures. Eggs were found to hatch in 13 to 32 days when the mean daily temperature was 80 degrees F. in May and early June, and 13 to 23 days during July and August when mean temperatures were above 80 degrees. Humidity apparently has little effect upon the speed of development or upon oviposition. This corroborates the results obtained by Clark (1935) who demonstrated that low temperatures retard and high temperatures accelerate development in **Rhodnius prolixus** Stal., a closely related species, while a normal humidity range has little effect.

Upon dissecting newly-molted females, it was found that seven to fifteen eggs are matured in the ovarioles. These are normally not deposited until the female has been fertilized and obtained a blood meal. Oviposition began four to six days following a blood meal and one to five eggs were deposited daily, depending upon the temperature, until the ovarioles were empty. The female then matures a second group which are not deposited normally until after the next blood meal. In several cases observed, females that were prevented from fertilization retained the initial group of eggs in the body until death.

From six to eight days prior to hatching, the egg turns pinkish, the color becoming more intense the closer the embryo approaches eclosion. This color change apparently is caused by the chorion which allows the embryo color to show through.

In nature the eggs are laid beginning in May and ceasing about the middle of September.

Fertilization and Blood Meals. The newly-molted adults migrate from the wood rat nests for fertilization. They become positively phototropic at this time, use their wings, and may be collected about lights in nearby areas. One fertilization apparently lasts the female throughout her life. Once the female has been fertilized, she finds a host, engorges, and begins the establishment of a colony.

During the 24 hour period following engorgement, **T. sanguisuga** eliminates a considerable quantity of liquid fecal material. This initial elimination consists of the excess water taken in with the engorged blood, and the residue of metabolism remaining in the Malphigian tubules from the last engorgement. Later excretions consist of a meconium of darker material which contains considerable quantities of hemoglobin and very little moisture. At the completion of engorgement, the insects were observed to defecate the contents of the fecal pouch, a function characteristic of the genus. The above observations are similar to those of Wigglesworth (1931) in his studies of **Rhodnius prolixus** Stal.

Hosts. The female, following fertilization, seeks a meal of blood from some source, preferably a mammal. In most cases, it enters the burrows of its normal host which in this region was found to be a wood rat, **Neotoma floridana baileyi** Merriam. The species is by no means host specific, either in the laboratory or in the field; specimens were observed to enter stables and feed upon horses and chickens, and go into homes where in several cases both nymphs and adults were taken engorged from the beds of inmates. In the field, they were taken from the burrows of the western cotton rat, **Sigmodon hispidus texianus** (Audubon and Backman), and in all probability feed upon other rodents and animals present in the environment. In the laboratory there was no difficulty in obtaining feedings upon guinea pigs, horses and mules, the rhesus monkey, and man.

The Nymphal Instars. Through laboratory rearing and by measurement of the head capsules of nymphs, **T. sanguisuga** was found to have eight nymphal instars. The overall size of the insect proved to be a very poor criterion for determining the instar, since the abdomens may be in various stages of distension with blood and distort the proportions. A more satisfactory means of determining the instar was through the measurement of the head capsule immediately posterior to the eyes. Measurement of the head capsules of dried specimens showed that the increment of size was approximately 0.1 mm. per instar. Results of the measurement appear in the following table.

Length of the Life Cycle. The life cycle was found to be about 450 days in laboratory rearings. Estimates of the length of the cycle in nature were made upon the basis of the average length of instar, the length of adult life, and the length of the active season in this region. These cycles were calculated to be considerably longer than the cycle in the laboratory which makes no allowance for seasonal activity.

The average length of instars in laboratory (and seasonal rearing) was found to be approximately 41 days. No appreciable difference in length

Table II Width of the head capsule of dried specimens in millimeters

Instar	Greatest	Least	Averages
First	0.431	0.425	0.428
Second	0.536	0.534	0.535
Third	0.653	0.620	0.642
Fourth	0.750	0.719	0.738
Fifth	0.872	0.856	0.864
Sixth	0.963	0.948	0.956
Seventh	1.071	1.071	1.071
Eighth	1.193	1.147	1.168
Adult	1.078	1.068	1.071

of instar was noted between the earlier instars and the later ones. Seventy-five per cent of the nymphs molted following a single engorgement and are designated as Group I. The remainder, except two, molted following two engorgements and are designated as Group II. These engorgements were made in the apparatus described previously for maintaining the colonies in the laboratory and approached natural conditions where the insects have access to an animal that is capable of movement. The insects that failed to molt following a single engorgement are considered to be those that were disturbed during feeding, thereby not becoming fully engorged; since full engorgement is considered necessary to stimulate the molting hormones, (Wigglesworth, 1933), this group failed to molt and so required a second engorgement.

Group I averaged 36 days as the length of instar. During May and June, the average time was 40 days. When mean daily temperatures were higher during July and August, the period was shortened to 28 days. The average time between feedings in Group II was found to be 29 days during May and June and 26 days during July and August, with an average of 55 days between molts. Thus compiling the figures for both groups would give an average length of instar of 41 days.

The adults of **T. sanguisuga** are long lived. Wood (1941) reported that a female of this species lived 155 days on four feedings. In the present observations a female lived 81 days on three feedings of guinea pig blood, and another lived 102 days on three feedings. Last instar nymphs were found to molt to adults at Manhattan from May 1 to about October 15. Those molting late in the season appeared to remain in the nests until the following spring and constituted a portion of the adults found in the nests during the winter. Other adults, being long-lived, lived over from one season to the next.

The active season in the region of Manhattan appeared to be between 200 and 235 days per year, or from about March 15 to November 15. Although the insects may be active after March 15, they apparently do not engorge until about April 15, as shown in Table I. In a normal year it is doubtful if any engorgement takes place after October 30, though on

warm days the temperature may be high enough; but at night the temperatures would be such as to inactivate the insects. The season during which molting takes place is estimated as approximately 200 days.

The life cycle estimate of 450 days in the laboratory depends upon the availability of hosts and the relatively constant temperatures which do not occur in nature. In favorable seasons, four to five instars may occur each season. All instars except the first may be found in the wood rat nests at any time of the year, as may be seen by reference to Table I. Since the females lay eggs at intervals throughout their lives, a great complexity in nest composition becomes inevitable. Thus, a first instar arising in May when the first series of eggs are hatched would undergo three instars the first summer, over-winter as a third instar nymph, pass four or five instars the second summer, and over-winter as an eighth instar nymph. This individual would molt to an adult in the spring and pass the third season as adult, and might even pass the third winter in the adult stage. The life cycle as based upon this example would cover approximately three years, making the **Triatoma** an excellent reservoir for infection.

Sex Ratio. Field collections, as shown in Table I, show that approximately 41 per cent of all adults collected were males, while the laboratory rearings of 16 eighth-instar nymphs to adults gave approximately 32 per cent males. On the basis of collections and rearings, it is evident that there are more females than males, but the exact ratio has not been determined.

Feeding Observations. Triatoma when hungry were found to feed readily upon mammals of several species. To check the details of engorgement, the author allowed a number of laboratory-reared **Triatoma** to feed upon the back of the hand. The bite of the insect was found to be somewhat anesthetic, since the host does not become disturbed during the feeding process lasting from three to eight minutes. The only indication of the presence of the insect was a slight tickling sensation when the proboscis was first introduced, and no reaction followed the bites. However, severe reactions have been observed and reported from several individuals sensitive to the bites of this species.

Feedings occurs only during the dark hours of the day or under darkened conditions. Insects were fed upon horses between the hours of 8 and 10 p.m. They were left in contact with the animal for a period of 20 minutes in a specially prepared screen cage that was taped to the side of the animal. Those insects in a physiological state of hunger fed readily, and those not in this condition could not be induced to feed under any conditions.

SUMMARY

1. **T. sanguisuga** was calculated to have a life cycle of approximately three years under natural conditions in Kansas, with eight nymphal instars and an adult stage.

2. The natural host in this region was found to be the wood rat **Neotoma floridana baileyi** Merriam, which is the common wood rat of the region

found in the pastures along the hillsides. The western cotton rat, **Sigmodon hispidus texianus** (Audubon and Backman) serves as an occasional host. So do other animals living in the environment.

3. The adult female is long-lived and lays a group of eggs following each blood meal. Temperature affects the development of the insect and of its eggs, in that high temperature accelerates and low temperature retards the development. Humidity does not appear to affect the development except as regards molting, and high humidity is generally avoided by the insect in its normal environment.

4. The life cycle of three years duration could make the insect important as a reservoir host of equine encephalomyelitis virus; coupled with the fact that the insect will feed upon almost any animal, this could make it one of the important factors in the maintenance of the disease among rodents and wildlife in the region of eastern Kansas.

BIBLIOGRAPHY

Clark, Nancy
Effects of temperature and humidity upon the eggs of the bug, **Rhodnius prolixus**. Jour. Animal Ecol., 4:82-87. 1935.

Davis, D. J., McGregor, T., and de Shazo, T.
Triatoma sanguisuga (LeConte) and **Triatoma ambigua** Neiva as natural carriers of **Trypanosoma cruzi** in Texas. Pub. Hlth. Repts. 58:353. 1943.

Kimball, B. M.
Conorhinus sanguisuga, its habits and life history. Kans. Acad. Sci., Trans. 14:128-131. 1894.

Kitselman, C. H., and Grundmann. A. W.
Equine encephalomyelitis virus isolated from naturally infected **Triatoma sanguisuga** (LeConte). Tech. Bul. 50. Kans. Agri. Exp. Sta., 15 pp. 1940.

LeConte, J.
Remarks on two species of American Cimex. Proc. Acad. Nat. Sci. Philia. 7:404. 1855.

Readio, P. A.
Studies on the biology of the Reduviidae of America north of Mexico. Kans. Univ. Sci. Bul. 17:5-241. 1927.

Usinger, R. L.
The Triatominae of North and Central America and the West Indies and their public health significance. Pub. Hlth. Bul. 228. 1944.

Walsa, B. D., and Riley, C. V.
Parasites of humans and animals. Amer. Ent. 1:84-88. 1869.

Wigglesworth, V. B.
The physiology of excretion in the bloodsucking innsect **Rhodnius prolixus**. J. Exper. Biol. 8:411-426, 428-442, 443-451. 1931.
Hormones controlling moulting and metamorphosis in **Rhodnius prolixus**. Quart. Jour. Micro. Sci., 76:269-318, 77:191-222, 79:91-121. 1933-1936.

Wood, Sherwin F.
Notes on the distribution and habits of the Reduviid vectors of Chagas Disease in the southwestern United States. Pan-Pacific Ent. 17-85-94. 1941.

INJURY TO RASPBERRY BY A MEADOW GRASSHOPPER[1]

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An unusual type of insect injury was observed in a small planting of raspberries near Fayetteville in the fall of 1945. The damage resulted from oviposition in the canes by a meadow grasshopper, **Orchelimum vulgare** Harris.[2] There is no previous record of such injury to raspberry in Arkansas although it has been noted elsewhere in several instances. A detailed account of damage by this species in Illinois is given by Metcalf and Colby (3).

The procedure followed by the ovipositing female was observed many times. Briefly, a cane is grasped firmly by the first and second pairs of legs; the insect then repeatedly grips the cane with the mandibles, tugging first in one direction and then the other, until the bark is well splintered over an area about one-fourth inch in diameter. The ovipositor is then inserted through the wound into the pith, where an egg is deposited. Additional eggs are commonly deposited in the same site after further splintering. Ordinarily a lengthy series of these scars is made, spaced about half an inch apart on the cane. Metcalf and Colby (3) apparently observed the insertion of the ovipositor to precede the splintering procedure. Present observations indicate that the splintering occurs first and serves the purpose of preparing an entrance into the pith for the ovipositor. Hancock (1) also describes the splintering as preceding egg deposition in the case of **Orchelimum glaberrimum**, a species with similar habits.

The crop loss comes about when these weakened canes break as a result of wind, rain or snow. In the present case the loss would have been serious had the planting been of commercial extent. It was not unusual for half the canes on a plant to be affected.

Similar injury, probably by the same species, was found widely distributed on a large number of plant species. In no case other than raspberry was the damage of economic importance. Plants showing typical injury were as follows:

Field corn	**Zea mays L.**
Sweet corn	**Zea mays L.**
Johnson grass	**Sorghum halepense (L.) Pers.**
Lamb's quarter	**Chenopodium album L.**
Red raspberry	**Rubus idaeus L.**
Wild blackberry	**Rubus sp.**
Cultivated rose	**Rosa sp.**
Wild carrot	**Daucus carota L.**
Horse nettle	**Solanum carolinense L.**
Giant ragweed	**Ambrosia trifida L.**

[1] Research Paper No. 825 Journal Series, University of Arkansas. Published with the permission of the Director of the Arkansas Agricultural Experiment Station.
[2] Order Orthoptera, family Tettigoniidae.

Cocklebur	**Xanthium pensylvanicum** Wallr.
Chrysanthemum	**Chrysanthemum** sp.
Thistle	**Cirsium lanceolatum** (L.) Hill
Wild lettuce (two species)	**Lactuca** spp.

Injury to several other plant species is reported by Metcalf and Colby (3). Riley (5) notes injury to sorghum heads in Arkansas.

The oviposition scars might be confused with those made by cicadas, which are known to oviposit in low-growing plants. Newell (4) and Isely (2) have reported instances of cicada oviposition injury to cotton and other herbaceous plants. Apparently the two types of injury can be distinguished by the arrangement of splinters. In cicada oviposition scars the splinters tend to point in one direction. In meadow grasshopper injury the splinters are broken in the middle, and therefore point in two general directions.

Seasonal history notes indicate that this meadow grasshopper requires nearly the entire growing season to reach maturity and deposit eggs. A large bundle of corn tassels containing eggs in the main stem was placed in an outdoor cage for observation through the winter and spring of 1945-46. Hatching began on May 6, 1946. The cage was not maintained through the summer, but adults in the field were first noted in mid-August. Very little injury from this brood was seen. During the previous year, injury was first noticed October 8. New injury appeared for several weeks thereafter, or until cold weather arrived.

No control measures were attempted. It appears, however, that several measures suggested by Metcalf and Colby (3) might prove beneficial. Their observations indicate that leguminous crops are preferred for food and that injury is more severe where legumes are adjacent to raspberry plantings. Separation of these crops should therefore reduce injury. Destruction of infested canes apparently gave good results in Illinois. Since eggs are deposited in many species of weeds it is probable that clean cultivation and winter clean-up of fence-rows and weed patches would be beneficial.

LITERATURE CITED

(1) Hancock, Joseph L. 1904. The oviposition and carnivorous habits of the green meadow grasshopper (**Orchelimum glaberrimum** Burmeister). Psyche 11:69-71.

(2) Isely, Dwight, 1938. A cicada as a cotton pest. Jour. Kans. Ent. Soc., 11:142-143.

(3) Metcalf, C. L. and A. S. Colby. 1930. The meadow grasshopper, **Orchelimum vulgare** Harris, a new raspberry pest. Jour. Econ. Ent., 23:97-108.

(4) Newell, Wilmon. 1906. Notes on a little known insect enemy of cotton and corn. U. S. D. A. Bur. Ent. Bul. 60:52-58.

(5) Riley, C, V, 1893. Notes from correspondents. Insect Life 5:204.

AN UNUSUAL WEATHER SEQUENCE ACCOMPANYING THE SEVERE POTATO PSYLLID OUTBREAK OF 1938 IN NEBRASKA[1]

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A study of the summer weather records for Scottsbluff, Nebraska, covering the 26-year period from 1921 through 1946 has revealed some interesting facts not previously reported regarding the relationship of weather to the occurrence and abundance of the potato psyllid, **Paratrioza cockerelli** (Sulc). Entomologists, potato growers, and others closely connected with potato production in western Nebraska have believed for several years that cool weather or the absence of high temperatures in July is a necessary prerequisite for the development of large psyllid populations. However, the extremely severe psyllid outbreak of 1938 was accompanied in this area by an unusual weather sequence. It is true that July of that year was cool, but the season was extraordinary in that July was also wet, followed by an exceptionally warm August and September. It is the purpose of this paper to show how such weather would provide ideal conditions for psyllid development under the cropping system practiced in the North Platte Valley. Although the present discussion is based on data from one locality, the relationship observed here most likely exists in certain other northern areas where populations of this psyllid only occasionally become large enough to cause serious trouble.

Review of Literature

Psyllid yellows, a disease produced by the feeding activities of the nymphs of the potato psyllid, caused an estimated loss of 25 per cent (more than one million bushels) of the western Nebraska commercial potato crop in 1938. Additional damage in the form of early sprouting and spoilage of tubers in storage also resulted (1). Although the relationship of the psyllid to the diseased condition was unknown previous to 1927, field notes by Werner (8) indicate that this pest may have been responsible for occasional losses in this area, at least since 1922. In 1922 he reported "abnormal plants were causing concern to a serious extent." However, psyllid-yellows disease was far more serious and caused greater losses in Nebraska during 1938 than in any previous or subsequent season (3). According to Werner (8), psyllids were prevalent all over the state early in the summer of 1938 and in western Nebraska they had become "extremely abundant by mid-September."

The detrimental effects of high summer temperatures on psyllid abundance have been noted by several individuals (2, 4, 5, 6, 7, 8). Hartman (2) has shown from field observations in Wyoming that psyllid damage is lessened by high summer temperatures. Laboratory studies made by List (4) indicate "that the species thrives best at about 80 degrees . . . . Oviposition, hatching and survival are definitely reduced under 90 degrees constant temperature, while a temperature of 95 degrees for only two or three hours per day permits

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little, if any, increase in numbers. One hundred degrees for one or two hours of the day are very definitely lethal to eggs and nymphs and practically stop all egg laying." Werner's (8) study of weather data from various localities in western Nebraska indicated that "psyllids have been most abundant in cool years and least abundant in years with many hot days." On the basis of field studies, Wallis (5 and 6) correlated the seasonal fluctuation in psyllid population in western Nebraska during 1939 and 1940 with the maximum temperatures. He found that as the average maximum temperature reached a high level in July, the psyllid population dropped only to increase again during August and September with the return of cooler weather. In a recent paper Wallis (7), discussing the seasonal occurence of psyllids, states "populations generally built up on early potatoes which reached their maximum growth in July. This fact indicates that large plants protect psyllids from high air temperature." He further noted that "High temperatures apparently have little retarding influence on the development of psyllid infestations in August, ..."

Comparison of the Weather Data

With the exception of 1922, the summer weather of 1938 differed markedly from all others of the 26-year period (1921-1946). The rainfall in July, 1938, was high, the total being 2.54 inches as compared to 1.33 for the average. In only three other seasons, namely, 1922, 1923, and 1928 was the precipitation for that month greater. Although the mean July temperature was barely below average for the period, on only three days did the maximum temperature attain or exceed 95 degrees during the first two-thirds of the month. July in only three other years had fewer such hot days during the first 20 days.

August of 1938 was dry and exceptionally warm. Only once during the 26-year period was the average temperature higher. On fourteen days the temperature attained or exceeded 95 degrees and this in other years was equalled only once and surpassed but twice. Furthermore, there were six days in August, 1938, when temperatures of 100 degrees or higher occurred. The nearest approach to this record was August, 1936, when four such days were recorded. For the 26-year period the average number of days during August when temperatures reached 100 degrees or more is but 1.2 days.

September likewise was warm. The mean monthly temperature was 65.4 degrees which, except for 1931 when the mean also was 65.4, is the highest for the entire period. Also the average minimum temperature was higher in 1938 than for any other September during the 26-year period.

Pertinent weather data for the interval 1938 to 1946, along with averages for the 26-year period (1921-1946), are given in Table 1.

Discussion

No actual psyllid population records are available for 1938, but tremendously large numbers must have been present. Not only was serious damage experienced in Nebraska but psyllid injury was reported from Colorado, Wyoming, Montana, and even Canada. A series of favorable conditions involving weather, host plants, and insects apparently coincided

over a large portion of the range of the species to produce that outbreak. In 1939 the psyllid infestation in Nebraska was low (5). Since that time fluctuations have occurred from year to year with numbers present one season having no noticeable influence on the population the following year. Apparently the insect does not hibernate in this area (7).

In Scotts Bluff County there have been in the past essentially two potato crops: an early crop (at present representing only a small percentage of total potato acreage) is planted in April and early May and harvested in late July and early August; the principal or late crop is planted in June and harvested late in September and early October.

Available evidence indicates that in western Nebraska the "critical period" (when hot days are most effective in reducing psyllid populations) extends from about June 21 to July 20 (5, 6, 8). During this interval, vines in late fields are only emerging and becoming established. Hot days then are especially effective in preventing the establishment of a destructive psyllid infestation in late fields. The small plants afford little protection, and high temperatures at that time are lethal to the eggs and young nymphs.

The situation in the early-planted fields is entirely different. Wallis (5) found that temperatures within the large plants may be 15 to 20 degrees below that of the surrounding air on hot July days. Psyllids are thus protected from the heat and the populations continue to increase in early-planted fields (Table 2). It seems apparent, therefore, that as potato vines in late-planted fields become larger and the foliage more dense, the adverse effect of high summer temperatures on psyllid development is reduced. In fact, the high temperatures that would be detrimental earlier in the season become beneficial to the psyllid in that they prevent the temperature around the base of the plant from becoming too low for optimum development. Thus the unusually warm August and September of 1938 most likely accounted for the great psyllid population increase on the late crop and the resultant heavy damage. Such conditions not only permitted the psyllids to develop normally, but the lengthened season extended the breeding period. An examination of conditions prevailing during 1941 and 1942 supports this view.

In both 1941 and 1942, psyllids appeared early and rather abundantly on volunteer potato plants, cull dumps, early-planted potatoes and certain spring hosts. Although in each of these seasons July averaged cooler than in 1938, in 1941 there were eleven and in 1942 ten days in which temperatures reached 95 degrees or more as compared to six for 1938. These warm days may have been partly responsible for subsequent low populations of 1941 and 1942. However, the population trend in early fields during 1941 was definitely upward throughout July and early August. In spite of the warm July days the stage appeared set for serious psyllid injury to the late crop, but it failed to develop (Table 2). A similar trend occurred in the 1942 early fields. One logical explanation for the lack of late season build-up would seem to be that August and September of both years were considerably cooler than the same months in 1938.

Table 1. Comparison of certain weather data as recorded at Scottsbluff, Nebraska, during the period 1938 to 1946 with averages for the 26-year period (1921-1946).

Season	Total Precipitation (inches)		Temperature						
			July		September		August		
	July	August	Mean	Av.Ma.	Mean	Av.Ma.	Mean	Av.Ma.	Av.Mi.
1938	2.54	0.69	74.4	90.2	75.1	92.5	65.4	81.2	49.6
1939	0.44	1.11	78.9	97.2	70.7	87.9	64.0	81.4	46.7
1940	1.38	0.47	76.3	94.4	69.7	86.9	64.8	80.8	48.9
1941	0.94	1.45	72.8	90.5	71.2	86.4	59.7	76.5	42.9
1942	1.40	0.40	73.2	91.7	70.3	88.1	58.5	76.5	40.5
1943	0.20	0.38	74.6	92.4	73.0	91.6	60.3	81.4	39.3
1944	1.99	1.37	71.0	85.8	71.9	88.2	62.1	79.2	45.0
1945	1.84	1.92	72.8	88.0	70.2	84.8	57.4	74.4	40.5
1946	0.07	1.08	75.8	92.3	70.6	85.7	61.6	77.0	46.1
Avg. 26-yr. period (1921-1946)	1.33	1.26	74.5	91.4	71.9	88.6	61.6	78.8	44.3

Table 2. Average number PARATRIOZA COCKERELLI adults collected per 100 sweeps of insect net in early, medium, and late potato plantings at Scottsbluff, Nebraska, in 1941.

Date of Collections		Date Fields Planted		
		April 26-28	June 2	June 20
May	30	1.3		
June	6	3.3		
	13	2.6		
	21	4.3		
	27	7.8		
July	3	9.6	1.3	
	9	40.3	1.3	0.8
	16	31.8	2.0	0.3
	23	45.8	1.3	0.8
	31	42.3	2.3	2.1
August	8	69.4	4.6	3.3
	13		3.6	2.8
	19		5.0	3.6
	28		7.6	8.5
September	5		19.3	16.1
	12*			3.6

* An early frost occurred on September 9.

Little is known concerning the source of the spring infestations and, for some reason, the initial population may have been extraordinarily heavy in 1938. Nevertheless, data presented here indicate a very definite relationship between the unusual weather sequence of a relatively cool, wet July,

followed by an exceptionally warm August and September, and the severe psyllid outbreak occurring in western Nebraska that season. Only once before during the period under discussion did such a weather sequence occur and that was in 1922, or the year Werner (8) first noted a serious number of abnormal plants with all the symptoms of psyllid yellows. Although the insect-disease relationship was unknown at that time, it is quite likely that psyllids were very abundant in Nebraska that year.

Summary and Conclusion

A study of the weather data for Scottsbluff, Nebraska, during the 26-year period, 1921-1946, shows that the summer of 1938 was peculiar, in that an extraordinarily wet July with very few hot days was followed by two months of exceptionally warm weather. It was that season in which psyllid yellows disease was unusually severe and was responsible for an estimated loss of 25 per cent of the commercial potato crop.

From what is known of the seasonal life history of the potato psyllid such a weather sequence provides conditions approaching the optimum for the development of a heavy population of this insect. The absence or infrequent occurrence of hot July days permits the psyllid to migrate from early summer hosts to the late crop and there become established on the small plants at a time when the foliage offers little protection from the heat. Later, however, relatively high temperatures become essential for the maintenance of optimum developmental conditions, when vine growth is dense enough to shade the lower portions of the plants and the soil surface.

In order for serious psyllid injury to occur in late potato fields of western Nebraska, there appears to be needed a source of early infestation and a favorable weather sequence of a cool, moist late June and July followed by an unusually warm August and September. Sources of initial infestations are not fully understood, but the increasingly popular local practice of removing potential spring and early summer breeding places through the elimination of early potato plantings and volunteer growth on cull dumps should serve to curtail psyllid populations considerably. Such practices greatly lessen chances of another serious psyllid epidemic in this area.

LITERATURE CITED

1. Hankins, T. H., "Psyllids in 1938 and the Outlook for 1939." Twentieth Ann. Rept. Nebr. Potato Improv. Assoc. pp. 33-35. (1939)
2. Hartman, Glen, "A Study of Psyllid Yellows in Wyoming." Wyo. Agr. Exp. Sta. Bull. No. 220. (1937)
3. Jensen, James H., "Psyllid Yellows in Nebraska—1938." Plant Disease Reporter, Vol. 23, pp. 35-36. (1939)
4. List, G. M., "The Effect of Temperature upon Egg Deposition, Egg Hatch and Nymphal Development of Paratrioza cockerelli (Sulc)." Jour. Econ. Ent., Vol. 32, pp. 30-36. (1939)
5. Wallis, R. L., "The Potato and Tomato Psyllid." Twenty-first Ann. Rept. Nebr. Potato Improv. Assoc. pp 5-9 (1940)
6. ———, "The Psyllid Situation in 1940." Twenty-second Ann. Rept. Nebr. Potato Improv. Assoc. pp. 10-13. (1941).
7. ———, "The Seasonal Occurrence of the Potato Psyllid in the North Platte Valley of Wyoming and Nebraska." Jour. Econ. Ent., Vol. 39, pp. ..... (1946).
8. Werner, H. O., "Occurrence of High Temperatures in Western Nebraska and Their Possible Relationship to Occurrence of Psyllids." Better Potatoes in Nebraska. Vol. 2 (6 and 7), pp. 7-12. (1939).

A NEW GENUS OF CORIXIDAE

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Some years ago in examining the Matsumura types of Corixidae, I was impressed by the uniqueness of his **C. miyakei** and recently, in revaluing the genera of the world, Doctor Reece I. Sailer, Miss Addie Egbert and I have decided that a new genus should be proposed for this species so that it may be included in the key which is presented in a forthcoming paper.

Xenocorixa new genus

Having the general facies of some **Hesperocorixa**. Lateral lobe of prothorax elongate, its anterior distal angle produced. Mesoepimeron very broad with a secondary suture extending across it from the lateral bend to the inner basal angle of the mesoepimeron. Metaxphus well developed. Legs short and stout. The hypo-ocular suture of the head arises near the rounded inferior angle of the eye and curves laterad to a point on the genal margin less than half way along the ventral margin of the eye. The last antennal segment very short, not over thirty percent of third segment. Pronotum and hemelytra shining, the former rastrate. The pruinose area along the base of the claval suture short and broad; vein M distinct but almost parallel with and very near to vein Cu. Males with dextral strigil.

Genotype: **Xenocorixa vittipennis** (Horvath) (=**C. miyakei** Mats. and **S. horni** Jaczewski).

NOTES ON KANSAS BUTTERFLIES WITH DESCRIPTION OF A NEW SUBSPECIES.

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For the past several years we have been collecting in the "Red Hills" of Barber County, Kansas, and south into Oklahoma around Freedom.

There are several species of butterflies of this area that show subspecific characters, one of which is described in this paper. In addition one new species has been discovered which is being described in a separate paper by our good friend, H. A. Freeman.

During the collecting season of 1946 we were able to collect a good series of **Amblyscirtes oslari** Skin. in this area, definitely establishing that this species is a native of Kansas. It frequents the narrow canyons of the area.

A long series of **Glaucopsyche lygdamus** (Doubleday) was collected which merit subspecific status.

Glaucopsyche lygdamus jacki new subspecies.

Briefly this subspecies might be described as having the maculation of eastern **lygdamus** and the size of western **lygdamus**.

Male: Upper Surface: Wings with narrow black border fringed with

white. Costal area of forewing dusted with white. Outer fourth of veins edged with black, balance of veins lightly dusted with white. Remainder of wings bright blue with iridescence from green to purple depending on angle of refraction. The bright blue color resembles the color of **lygdamus** from Michigan and Ontario, except that it is much brighter.

Under Surface: Ground color grey-brown, showing more brown than **oro** Scudder from Colorado but less brown than in Michigan or Ontario specimens. Forewing has a submarginal row of black spots (normally 6 or 7) and a black bar in the discal area all faintly edged with white. Hindwing with a submarginal row of black spots (normally 8 or 9) black discal bar and a black spot above the discal bar. Less than 10 per cent of the specimens show a black spot between the body and discal spot. All spots faintly edged with white.

Female: Upper Surface: Fringe of wings white with black discal bar in forewing. Ground color of wings dark slate to black, inner half of forewings sparsely dusted with bright blue with even less blue on hindwings.

Under Surface: Similar to males.

There are four distinguishing characters in this subspecies:

1. The bright blue coloring has a more metallic luster than any other **lygdamus.**
2. The grey-brown ground color of undersurfaces intergrades between eastern and western specimens.
3. The blue on the females is generally more sparse than on other **lygdamus.**
4. The veins of the males appear raised due to the peculiar edging.

Holotype: Male. Expanse 26 mm. Barber County, Kansas, 4-7-46.

Allotype: Female. Expanse 29½ mm. Barber County, Kansas. 4-7-46.

Paratypes: 73 males and 15 females, Barber County, Kansas, 4-7-46.
31 males and 16 females, Barber County, Kansas, 4-14-46.
2 females, Barber County, Kansas, 4-28-46.
2 males, Freedom, Okla., 4-21-46.
2 males and 2 females, Salt Plains, Okla., 4-12-46.
1 male, Salt Plains, Okla., 4-13-46.

Type series collected by Dr. and Mrs. R. C. Turner, Jr., Dr. J. R. Turner, Mr. and Mrs. Harry E. Jenista and sons, Leon, Harry Edward and Marion, Mr. and Mrs. Don B. Stallings, and sons, Dee and Jack.

Names in honor of John (Jack) R. Stallings, son and nephew of the authors.

The range of this subspecies can be expected to be west of a line drawn north and south through Wichita, Kansas, and Enid, Okla., ranging west on the plains till it is replaced by **oro** the mountain subspecies in Colorado. Northward it should range into Nebraska and should occur throughout western Oklahoma and northern Texas, meeting **oro** in New Mexico.

Holotype and allotype will remain in the author's collection for the present. Paratypes will be distributed to various museums and private collections.

NEW NORTH AMERICAN MUSCOID DIPTERA[1]

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The following descriptions of new sarcophagine genera and species are based upon material in the Snow Entomological Collections at the Kansas University and in my collection. I am greatly indebted to Dr. R. H. Beamer for the privilege of studying the extensive accumulations of Sarcophaginae added to the Snow Collection during recent years. All types of new species represented in the latter material are returned to the Kansas University Museum as mentioned under the descriptions.

Xenoppia monela, n. sp.

Fig. 1

Male.—Front at vertex 0.30 of head width, slightly narrowed downward thence widening gradually in facial angle; frontal vitta deep brownish black, much wider than parafrontal; ocellars proclinate, hairlike; outer verticles well developed; orbital bristles absent; frontals in a single row diverging beneath antennal base and extending almost to apex of second segment; parafrontals and parafacials gray pollinose, with a row of delicate hairs extending from vertex along eye margin to cheek grooves, lowermost two or three hairs somewhat coarser but not bristly; cheeks gray pollinose, one-fifth eye height; vibrissae on oral margin, latter moderately bowed forward; facial ridges bare; antennae black, nearly as long as face, third segment subequal to one-fourth longer than second; arista black, basal third moderately thickened and bearing rather short hairs which scarcely exceed the maximum diameter of the arista; proboscis short, labella fleshy; palpi black, bowed and moderately thickened apically; eyes bare; occiput plumbeous, with three rows of black hairs above and with finer pale hairs at middle below.

Thorax and scutellum black, gray pollinose, with three not very sharply defined dark vittae above. Chaetotaxy: acrostichal 0,1 (prescutellar small); dorsocentral 2,3; intraalar 1; supraalar 3; presutural 1 (outer); sternopleural 3; scutellum with 2 lateral (large), apical and discal pairs absent; prosternum and propleura bare; postnotal slopes setose.

Legs black; middle femur without comb; middle tibia with two large anterodorsal bristles; hind tibia not villose, claws and pulvilli moderately long.

Wings gray hyaline; first vein bare, third setulose nearly to small cross vein; first posterior cell narrowly open well before wing tip; costal spine strong, much longer than small cross vein.

Abdomen black, with grayish pollen in a tessellated pattern, which extends thinly to hind margin on last three segments above; median vitta broad and rather constant, one on either side narrower and changeable with angle

[1]Contribution No. 1033, Division of Entomology, Texas Agricultural Experiment Station.

of view; first segment without median marginals, second and third each with one large pair; fourth with a complete marginal row.

Hypopygium large, black with plumbeous pollen above; first segment bearing one pair of discal bristles and a marginal row of six; second segment near base above with four good-sized upcurved bristles; fifth sternite black, deeply incised with inner margin of lobes widely divergent behind; forceps black, rather short, tapering and gently bowed in profile, united to tip and clothed with fine hairs on the slightly keeled hind side; hind clasper slender, curved and tapering to sharp tip; front clasper much heavier, directed forward from near base, tip broad, obliquely truncate; penis brownish with a slender unjointed stalk, bowed forward and upward at apex terminating in a vaselike tip, with the incurved upper apical extremity slightly produced; immediately in front of latter are two small processes, one very delicate or hairlike curved laterally, the other shorter and heavier directed basad.

Female.—Front at vertex 0.40 of head width, equibroad nearly to antennae; frontal vitta subequal to slightly wider than one parafrontal; two proclinate orbitals; abdomen broad ovate; genitalia black, first segment devoid of hairs on upper surface but hind margin fringed with bristly hairs; sixth and seventh sternites black or reddish black, with hind margin of last broadly and deeply emarginate; legs stoutish, claws and pulvilli shorter than last tarsal segment.

Length, 8.5-9.5 mm.

Holotype: Male, Cape Sable, Florida, February 1, 1941 (L. L. Pechuman). Allotype: Female, Harris County, Texas, May 29, 1921 (H. J. Reinhard). Paratypes: 1 male, "Cameron County, Texas, November 19, 1931"; 1 female, "Charleston, S.C., Jan. 3"; and 1 male, Raleigh, N.C., July 17, 1940 (C. S. Brimley).

The species differs from the genotype, **X. hypopygialis** Townsend (**Camptopyga aristata** Aldrich) mainly in genital peculiarities; also, the parafacials are much less strongly bristled and the second abdominal segment in the male bears a pair of large erect median marginals.

Xenoppia valgata, n. sp.

Fig. 2

Male.—Very similar to the preceding species in most essential details but the second abdominal segment lacks large median marginals, the parafacials bear a single good-sized bristle on the lower extremity near eye margin, and the genitalia are strikingly different. Other minor differences may be mentioned as follows:

Front at vertex 0.33 of head width (one specimen); parafrontals and parafacials subsilvery, cheeks and occiput cinereous; thorax with three moderately broad and well defined brownish vittae; two large intraalars; prescutellars small but distinct; abdomen above with whitish pollen which is heavier on basal margin of last three segments and interrupted by three fairly constant blackish vittae. Hypopygium large, subshiny black, lightly dusted with gray pollen above; forceps black, rather thick at base and

tapering in profile, flattened and subtriangular in rear view with narrow tips separated but not divergent; claspers short and curved, anterior ones broad to oblique tips; penis reddish brown, stalk long and slender, not jointed but sheathed on basal three-fifths or more; apex of penis expanded and subdivided with the forwardly directed part terminating in a narrow pale membrane, on the hind side distally are two slender blunt-tipped processes, shortly above these is a second and more delicate or hairlike pair that curve outward thence upward; fifth sternite blackish, with a narrow median incision, lobes thickly beset with short black hairs on hind margin.

Length, 7.5 mm.

Holotype: Male, Houston, Texas, May 27, 1921 (H. J. Reinhard).

Cattasoma, n. gen.

Male fifth sternite entire as in **Sarcofahrtia** and **Erythrandra** but differing from both in having a much smaller build; vibrissae short with tips scarcely meeting; male front in profile less prominent, wide and equibroad from vertex to antennae.

Frontal bristles rather weak, in single parallel rows stopping at or a trifle beneath antennal base; orbitals and outer verticals absent; ocellars widely divergent and slightly proclinate; antennae subequal length of face, third segment barely twice length of second; arista moderately thickened on basal third, short-haired to middle thence micro pubescent nearly to tip, second segment short; parafacials setose except on inner margin, not much wider than third antennal segment; facial ridges bare; vibrissae near oral margin and not very high above lower margin of head; haustellum very short, labella fleshy; palpi stout, spatulate; eye bare, nearly vertical, not quite reaching vibrissal level; cheeks three-fifths eye height; occiput convex with three rows of short bristly hairs above. Propleura and prosternum bare; postnotal slopes setose; anterior acrostichals absent, prescutellar pair well developed; postsutural dorsocentrals three; sternopleurals two; scutellum with two good-sized marginal and one smaller discal pair. Male claws and pulvilli moderately elongate, middle femur with comb. Wings reaching well beyond tip of abdomen; first vein bare, third setulose over halfway to small cross vein; first posterior cell narrowly open at costa about length of small cross vein before wing tip; costal spine small but distinct. Abdomen at base as wide as thorax but rather strongly narrowed towards tip; basal segments without median marginals, third with one slightly differentiated pair, fourth with marginal row of eight or ten somewhat stouter bristles; hypopygium prominent.

Genotype: **Cattasoma mediocris, n. sp.**

Cattasoma mediocris, n. sp.

Fig. 3

Male.—Front nearly half as wide as long, at vertex 0.33 of head width, diverging into facial angle on lower extremity; frontal vitta reddish brown, thinly pollinose, equibroad on entire length and much wider than parafrontal; antennae and palpi red, thickened tips of latter slightly infuscated;

parafrontals and parafacials pale yellowish gray, clothed with minute black hairs not arranged in distinct rows; cheek grooves red, this color extending across oral margin and upward to include lower part of face and its lateral ridges; cheeks beset with short fine black hairs; occiput cinereous, wholly black-haired.

Thorax black, densely gray pollinose, with three to five narrow and not very well defined dorsal vittae; pleural hairs fine and short, wholly black; scutellum black, with spare hairs on middle above; intermediate marginal bristle small.

Legs black, femora moderately stout, thinly pollinose; mid tibiae with one anterodorsal bristle; hind coxae not haired on hind side; claws and pulvilli equal or slightly exceeding length of last tarsal segment.

Wings hyaline; epaulets bright reddish yellow; hind cross vein oblique, joining fourth much nearer bend than small cross vein, latter slightly before apex of first vein; calypters white, rounded, hind lobes normal in size.

Abdomen wholly gray pollinose, with three black dorsal vittae, outer ones more or less interrupted and showing as spots in some views; sternites moderately exposed, fifth one entire and evenly rounded on hind margin.

Hypopygium rather large; first segment black, gray pollinose above, bearing a transverse row of four stoutish discals and four weaker marginal bristles; second segment obscurely reddish, thinly pollinose and clothed with fine black hairs; forceps short, reddish brown, narrow tips divided but not divergent; anterior claspers moderately strong, directed forward from near base, hind pair much shorter and visible only in direct ventral view; accessory process small, fingerlike, far before base of forceps; penis with a rather short slender basal stalk, terminating in a bowed and slightly enlarged hollow apex which has the apical extremity deeply emarginate, on the front side near middle and close to the stalk are a pair of small hook-like processes directed upward, with a second more loosely attached larger pair extending forward and upward from about the same level.

Length, 5.5 mm.

Holotype: Male, Big Bend Park, Brewster County, Texas, July 1, 1937 (R. H. Baker).

Cattasoma festinans, n. sp.

Fig. 4

Male.—Very similar to the preceding species in all essential items but at once distinguished by wide morphological differences in the genitalia.

Hypopygium reddish black basally, second segment wholly reddish, forceps red, short but slender, rather widely separated on apical three-fifths; accessory process small, well before base of forceps; anterior claspers unusually long, narrow at middle thence widened to a broadly rounded apex with the anterior apical extremity minutely dentate; penis gently curved and slender in profile, bearing a chitinized semitransparent process above middle on front side which extends forward between the anterior claspers; fifth sternite entire, wholly red.

Length, 4 mm.

Holotype: Male, Marathon, Texas, July 9, 1938 (Jean Russell), in the Snow Entomological Collections, Kansas University.

Cacotrophus, n. gen.

Head shape similar to **Cistudinomyia**, but the epistoma short and hardly narrowed from clypeus; latter much wider than parafacial; ocellars hair-like or entirely absent; male with well developed orbital bristles.

Vertex nearly one-third head width in both sexes, front equibroad to antennae; parafacial with single row of small hairs; facial ridges practically bare; vibrissae on oral but well above lower edge of head; frontals weak, in single rows slightly diverging anteriorly, one or two bristles below antennal base; verticals two pairs; orbitals two proclinate and one reclinate in female, one proclinate and one reclinate in male; antennae subequal length of face, second segment over half as long as third; arista moderately long plumose on basal half or more; proboscis short, labella large; palpi longer than haustellum; eyes bare; cheeks fully two-fifths eye height. Thoracic chaetotaxy: acrostichal 0,1 (prescutellar pair well developed); dorsocentral 3,4 (two immediately behind suture small); presutural 1 (outer); humeral 2; notopleural 2; sternopleural 2; scutellum with 3 lateral and 1 smaller discal pair, no apicals; prosternum, propleura and postnotal slopes sparsely setose. Legs long but not very slender; male mid femur without comb; hind tibiae not villose. Wings rather short; venation normal; costal spine vestigial. Abdomen ovate, flattened above, with tip broadly truncate in female; segments one and two without median marginals, third with one pair and fourth with a complete marginal row.

Genotype: **Cacotrophus beameri**, n. sp.

Cacotrophus beameri, n. sp.

Fig. 5

Male.—Head whitish pollinose on pale ground color, occiput darker and cinereous; parafrontals with only a few short inconspicuous hairs along outer margin; frontal vitta red, narrower than one parafrontal; antennae reddish brown; arista slender, a little thickened near base, tips moderately swollen; cheeks clothed with fine black hairs; eye slightly oblique, not quite reaching vibrissal level; occiput largely black-haired, a few paler ones at middle below.

Thorax black, gray pollinose, with three velvety black dorsal vittae, outer pair stopping shortly before scutellum, median one extending over disc of latter; pleura black-haired.

Legs black, tibiae with a slight reddish tinge in ground color; mid tibia with two smallish anterodorsal bristles; claws and pulvilli shorter than apical tarsal segment.

Wings hyaline; first vein bare, third setose less than halfway to small cross vein; first posterior cell open well before wing tip; epaulets blackish; calypters white, hind lobes rather small, longer than wide.

Abdomen black becoming reddish on sides, with moderately thick gray pollen on upper surface in a tessellate pattern leaving three black vittae which are changeable with the angle of view; fifth sternite reddish yellow, with a median V-shaped incision, lobes rather thickly clothed with fine black hairs on inner margin.

Hypopygium moderately large, red; first segment above thinly white pollinose, with a marginal row of eight or ten bristly hairs, no discals; second segment slightly pruinose to subshiny, with a vestiture of fine black hairs on entire surface above; forceps long, bowed and tapering in profile, divided beyond middle but tips not divergent; accessory process only a little shorter than forceps, narrow at base and gradually widened toward tip; anterior forceps reddish, broad on basal part suddenly narrowed and bowed forward on apical half; hind claspers yellow, strongly compressed, not quite so broad basally and gradually tapering outward to narrow curved tips; penis yellow, apparently single-jointed, curved forward and but slightly thickened to a rounded apical rim, the apex bearing a pair of small forwardly directed processes which are strongly bowed leaving a small opening beneath them visible in profile; from near base of penis behind a rodlike process extends briefly rearward thence down and forward between the posterior claspers reaching the penis stalk shortly above the point of curvature; the latter process is almost entirely obscured by the forceps and claspers in lateral view.

Female.—Very similar to male except for sexual differences. Genital segments red, retracted; orifice vertical and slitlike, margin of latter fringed with a row of black bristly hairs.

Length, 7 mm.

Holotype male and allotype female, Huachuca Mts., Arizona, July 8, 1932 (R. H. Beamer), in the Snow Entomological Collections, University of Kansas.

The species is named for Dr. R. H. Beamer, through whose extensive collecting of insects many new and unusual forms have been brought to light.

Sarcophaga pagella, n. sp.

Fig. 6

Traces to S. hospes in Aldrich's key, but the head pollen mostly grayish, first abdominal segment without median marginals, and the genitalia differing in morphological details.

Male.—Vertex 0.23 of head width, front equibroad to lower third thence widening in facial angle; frontal vitta velvety red to deep brown or black, wider than parafrontal; inner verticals straight, outer ones and orbitals absent; ocellars moderately large; frontals in single rows which diverge anteriorly, two or three bristles beneath antennal base; parafacials moderately wide, with black hairs on outer margin which became coarser near lower extremity; facial ridges finely haired to middle; antennae largely black, third segment hardly twice length of second, reaching to lower

fourth of face; arista long plumose on basal half or more; vibrissae on oral margin; palpi black, longer than haustellum; cheek one-third eye height; occiput with three rows of black hairs above, with some pale hairs above neck as well as below.

Thorax with rather dense gray pollen and three very distinct broad black vittae above; acrostichal 2,1 (all well developed, none near suture); dorsocentral 3,3; presutural 2 (inner one small); humeral 3; sternopleural 3; scutellum with two long lateral, 1 smaller decussate apical and and 1 reclinate more widely spaced subapical pair; prosternum and propleura bare; postnotal slopes setose.

Legs black; mid tibiae with two anterodorsal bristles; mid femur with comb; hind tibiae not villous; claws and pulvilli subequal apical tarsal segment.

Wings subhyaline; first vein setulose on basal half and third halfway to small cross vein; bend of fourth vein rectangular with a distinct fold; first posterior cell open well before wing tip; costal spine shorter than small cross vein; epaulets black; calypters white, hind lobes with a light brownish shade at middle.

Abdomen black, with gray pollen, which is interrupted on intermediate segments by three changeable black vittae; second segment with one pair of median marginals, none on first; last two segments each with a complete marginal row.

Hypopygium wholly red, small and in repose largely retracted; first segment lightly pale pollinose and bearing four to six smallish bristles on hind margin above; second segment at most pruinose, with more abundant black hairs, mostly fine and short; forceps with the joined basal part strongly convex and bearing fine recumbent hairs; beyond this they are bent backward thence evenly arcuate on hind edge to a pointed apex; on the divided free part of the forceps near middle a thin lateral micro-spined ridge extends obliquely downward from anterior to posterior edge; accessory process red, small, narrowed apically; penis jointed near base, stalk short, tapering and somewhat constricted at base of apical segment; latter short, slender, bearing a small bilobed process near base above and tapering to a simple rounded apex; claspers short, hind pair curved, pointed, the front ones straighter and blunt-tipped; fifth sternite yellow, retracted, apical incision V-shaped, lobes sparsely black-haired.

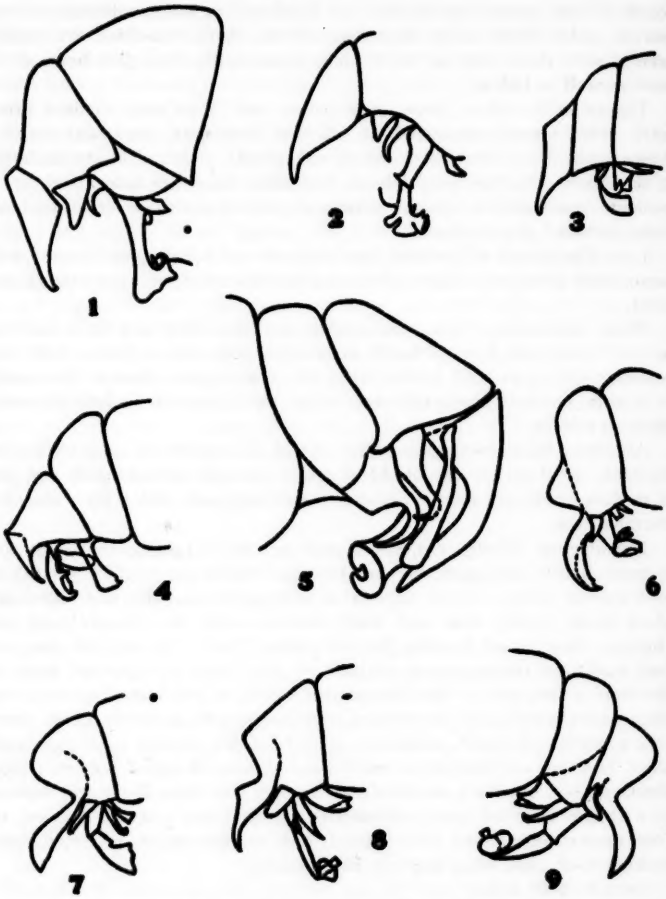
Length, 8-10 mm.

Holotype: Male, Bexar County, Texas, September 26, 1936 (H. J. Reinhard). Paratypes: 1 male, Menard, October 12, 1931 (H. E. Parish) and 1 male, Baboquivari Mts., Arizona, July 19, 1932 (R. H. Beamer) in the Snow Entomological Collections, Kansas University.

Sarcophaga devulsa, n. sp.

Fig. 7

Close to **S. spatulata** Aldrich (**Stenaulacotheca** Townsend), but considerably more robust in build; palpi and antennae black and there are slight differences in the genitalia:



Lateral View of Male Genitalia

Plate I

Figure 1. Xenoppia monela, n. sp.
Figure 2. Xenoppia valgata, n. sp.
Figure 3. Cattasoma mediocris, n. g. and n. sp.
Figure 4. Cattasoma festinans, n. sp.
Figure 5. Cacotrophus beameri, n. g. and n. sp.
Figure 6. Sarcophaga pagella, n. sp.
Figure 7. Sarcophaga devulsa, n. sp.
Figure 8. Sarcophaga convena, n. sp
Figure 9. Sarcophaga putilla, n. sp.

Male.—Front at vertex 0.17 of head width, front slightly narrowed near middle thence widening rapidly downward; head black, gray pollinose; parafacials abundantly haired on outer half, moderately wide; vibrissae near oral margin; facial ridges weakly bristled to middle; third antennal segment one and one-third times length of second; arista plumose to middle; two or three frontals below antennal base and moderately divergent from row; outer verticals vestigial; ocellars proclinate; proboscis short; cheeks slightly exceeding one-fourth eye height; occiput wholly black-haired.

Thorax gray with three wide black vittae above; dorsocentral 3,3; acrostichal 2,2; sternopleural 3; scutellum with 2 lateral, 1 decussate apical and 1 subapical pair; prosternum and propleura bare.

Legs black; hind tibiae not villose, preceding pair with one anterodorsal bristle; mid femur with comb; claws and pulvilli elongate.

Wings subhyaline, slightly infuscated basally; costal spine small but distinct; first vein bare, third haired halfway to small cross vein; calypters brownish.

Abdomen with changeable gray pollen and three black vittae above; basal segments without median marginals, last two each with a marginal row; fifth sternite blackish, divided, mostly concealed.

Hypopygium small, black, second segment slightly reddish above; forceps strongly convex near base behind, thence bowed backward; the free part pale yellow, thin or bladelike and beset with micro spines on sides, divided but not divergent in rear view; accessory process small, tapering to a delicate tip; penis rather slender, jointed, with yellow basal segment about as long as apical, latter bearing a pair of blackish lobes on front side which in lateral view appear as part of the main segment widening same to apex; claspers small and slender, hind pair hooked at tips, the anterior ones with broadened tips emarginate.

Length, 7.5-8 mm.

Holotype: Male, Amherst, Ohio, July 14, 1934 (H. J. Reinhard). Paratype: 1 male, same data as type.

Sarcophaga hunteri aenigma, n. subsp.

Male.—With the essential characters of **S. hunteri** Hough (**Protodexia** Townsend), including structural features of genitalia except the claspers and accessory process are considerably smaller and the posterior basal lobes of the forceps lack the characteristic tuft of long straight hairs on the apex.

Length, 5.5-6 mm.

Holotype: Male, Babylon, L. I., N. Y., August 28, 1935 (Blanton & Borders). Paratype: 1 male, Lakeville, N. Y., July 30, 1921 (H. C. Huckett).

Sarcophaga convena, n. sp.

Fig. 8

Allied to **S. flavipes** Aldrich (**Acridiophaga** Townsend), but the first vein bare, legs black and the fourth abdominal segment wholly red. Other differences are listed below.

Male.—Front at vertex 0.17 of head width, equibroad to middle thence widening rapidly downward; parafrontals and parafacials gray pollinose,

latter rather narrow, with two rows of black hairs becoming coarser or bristly below; frontal vitta black, wider than parafrontal; outer verticals and orbitals absent; ocellars slender, not large; frontals in single rows diverging anteriorly, two to three bristles below antennal base; vibrissae strong, slightly above oral margin; facial ridges black, setose almost to middle; antennae black, third segment twice length of second and reaching to lower fourth of face; arista with usual plumosity on basal half or more; proboscis short, labella large; palpi black, longer than haustellum; cheeks black gray pollinose, with black hairs, nearly one-third eye height; occiput with three rows of black bristles above and rather sparsely pale-haired below.

Thorax gray pollinose, with the usual three to five black vittae above; acrostichals 3,2; dorsocentrals 3,3; presuturals 2 (inner one smallish); scutellum with 3 lateral (intermediate one small), 1 good-sized decussate apical and 1 widely spaced subdiscal pair; prosternum, propleura and postnotal slopes haired.

Legs moderately long; hind tibiae not villose, middle pair with one anterodorsal bristle; mid femur with about four stubby spines on lower anterior edge; claws and pulvilli elongate.

Wings subhyaline; costal spine vestigial; first vein bare, third setulose nearly halfway to small cross vein; first posterior cell open well before wing tip; calypters large, white with a tawny tinge.

Abdomen black with fourth segment wholly red, gray pollinose above except on three changeable black vittae; last two segments each with a marginal row of stoutish bristles; one weak depressed median marginal pair on second segment, none on first; fifth sternite red, with an apical V-shaped cleft, lobes sparsely black-haired.

Hypopygium small, wholly red; first segment white pollinose, bearing four slender bristles on hind margin; second segment subshiny with sparse short black hairs above; forceps pale yellow, strongly humped on united basal portion, thence bent back and the free part obtusely humped near middle on hind side, latter beset with micro spines except on narrow forwardly bowed tip; penis reddish, slender, with basal segment slightly shorter than apical; latter very thin in profile, bearing a pale, semitransparent lobe on either side near tip, between these there is a small blackish process directed forward at nearly a right angle to the main segment; accessory process yellow, rather broad and parallel to rounded tip; anterior clasper yellow, stout, curved, with a thin oblique ridge near tip; hind clasper rather slender, tapering to an acute curved tip.

Length, 9 mm.

Holotype: Male, College Station, Texas, May 23, 1943 (H. J. Reinhard).

Sarcophaga putilla, n. sp.

Fig. 9

Male.—Very similar to the preceding species, except as follows: Front at vertex 0.20 of head width, slightly narrowed before ocellar triangle; parafacial nearly one-half clypeal width, with sparse hairs in a single row;

cheek one-third eye height; second abdominal segment without median marginals, fourth with a blackish tinge on narrow basal margin above; genital forceps with the free part evenly arcuate behind; penis stouter, with the apical lobes thick or padlike and covering all but extreme tip of the forwardly directed copulatory tube; anterior claspers stout and curved but not sharply ridged on outer side, tips rather broad and emarginate; accessory process small, bowed, tapering to a narrow tip; fifth sternite yellow, largely concealed.

Female.—Front at vertex 0.27 of head width, gradually widened forward to antennal base; outer verticals not developed; two stout proclinate orbitals; cheeks with coarse black hair, slightly over one-third eye height; apical scutellars lacking; fourth segment orange red, genitalia concolorous with subvertical oval orifice; sixth and seventh tergites rather narrow, transversely convex behind, directed up and rearward and the last tapering to a narrow rounded tip beset with small black hairs.

Length, 5.5–9 mm.

Holotype: Male, Amherst, Ohio, July, 1933 (H. J. Reinhard). Allotype: Female, same data except dated July, 1934. Paratypes: 2 males and 3 females, same data as type and 1 male, Wisconsin, July 1, 1930, without precise locality or collector's label.

Sarcophaga ignipes, n. sp.

Differs from the two preceding species in having bright red legs and palpi, and from S. **flavipes**, in having the prosternum and propleura haired, first vein of wing bare, and fourth abdominal segment wholly red.

Male.—Front slightly narrowed near middle, at vertex 0.18 of head width; parafrontals and parafacials subsilvery, the latter with two or more rows of black hairs becoming bristly below; outer verticals and orbitals absent; ocellars slender, long; frontals about twelve, rather strong, diverging anteriorly, three beneath antennal base; facial ridges bearing a few hairs next to vibrissae; latter large, near oral margin; antennae mostly black, third segment slender, barely twice longer than second; arista long plumose on basal three-fifths or more; palpi slender, longer than haustellum; cheek with gray pollen and coarse black hairs, over one-third eye height.

Thorax gray with three to five black dorsal vittae, strongly bristled; postsutural dorsocentrals 3, anterior acrostichals 3; prescutellars medium-sized; sternopleural 3 (large); scutellum with 2 lateral (hindmost reaching beyond base of third abdominal segment), 1 good-sized decussate apical and 1 subdiscal pair; postnotal slopes setose.

Legs long but not very slender, red with tarsi blackish; hind tibiae not villose, middle pair with one stout anterodorsal bristle; mid femur without distinct comb, the bristles spiny but rather widely spaced; claws and pulvilli long.

Wings gray hyaline; costal spine small; third vein setose three-fourths distance to small cross vein; hind and apical cross veins very oblique and in same plane, latter reaching costa well before wing tip; calypters large, hind lobes infuscated with narrow rim paler.

Abdomen gray tessellated above, with three dark vittae; basal segments without median marginals, third with a stout pair and four laterals at some distance from them; fourth segment with a complete marginal row; fifth sternite yellow, with an apical V-shaped cleft.

Hypopygium small, wholly red; genitalia as in **S. putilla**, but the penis considerably shorter, with apical lobes large but distinctly thinner in profile; posterior clasper very slender, tapering to a minute curved tip; anterior clasper short, not very stout, strongly bowed and blackish on apical half, tip blunt; accessory process slightly wider on entire length.

Female.—Front at vertex 0.24 of head width, diverging gradually to antennal base; two proclinate orbitals; outer verticals usually not differentiated; palpi at times infuscated apically; second antennal segment red; apical scutellars absent; second abdominal segment without strong median marginals, third and fourth bearing a complete marginal row; genitalia as in **S. putilla**; claws and pulvilli shorter than in male.

Length, 6.5-9 mm.

Holotype: Male, College Station, Texas, June 2, 1946 (H. J. Reinhard). Allotype: Female, same data except dated May 13, 1945. Paratypes: 4 females, College Station, Texas, May-June, 1944-46 (H. J. Reinhard).

Sarcophaga alopecis, n. sp.

Fig. 10

Male.—Like **S. falciformis**, except as follows: Front at vertex 0.21 of head width, narrowed before ocelli thence widening rapidly in facial angle; antennae wholly black, three-fourths length of face, third segment one-half longer than second; mesonotal hairs rather long and fine; sternopleura bearing three strong bristles and numerous long hairs some bristlelike above; second abdominal segment with one pair of well developed median marginals, third and fourth with a marginal row; genital forceps wholly red, in profile the basal part is strongly bulged with a deep emargination immediately below this, the free part beyond is rather broad, convex on the outer side which is thickly beset with minute stubby spines; anterior forceps short with slender tips slightly curved; posterior forceps somewhat heavier and more strongly bowed apically; penis with a short yellow basal segment, the apical one a little longer, rather slender, bearing a small black globular process and a pale crescentiform membrane on front side near tip; the extreme apex behind terminating in two small diverging pronglike processes which are bowed forward; fifth sternite red, lobes largely concealed, with sparse black hairs on hind margin.

Female.—Six specimens labeled as the males and presumably taken in company with same are provisionally considered as belonging here. Except for the usual sexual differences and grayer general aspect the characters are similar to the male. Genitalia red, with subchitinized apical sternites tapering distally to a blunt and moderately protruding tip.

Length, 6.5-10 mm.

Holotype: Male, Sioux City, Iowa, June 18, 1921. Paratypes: 3 males and 6 females same data as type.

Sarcophaga mendax, n. sp.

Fig. 11

Belongs to Aldrich's group A, having three post dorsocentral bristles, hypopygium wholly black and male hind tibiae villose. There appears to be no closely related species that has been previously described.

Male.—Front at vertex 0.20 of head width, slightly narrower below ocelli thence widening rapidly downward; parafrontals and parafacials pale yellowish gray pollinose, the latter with a row of hairs on outer margin becoming bristly on lower extremity; frontal bristles in single rows diverging anteriorly, two below antennal base; ocellars small; outer verticals absent; antennae black, reaching lower fifth of face, third segment not quite twice length of second; arista long plumose on basal three-fifths or more; vibrissae near oral margin; proboscis short, stout; palpi black, longer than haustellum; cheeks grayish, with black hairs, hardly one-third eye height; back of head with three rows of black bristles above and finer pale hairs around the middle and below.

Thorax gray pollinose with three to five black vittae above; prescutellar bristles medium large; anterior acrostichals vestigial; sternopleurals three; scutellum with two strong lateral, one small decussate apical and one preapical pair; prosternum and postnotal slopes haired; propleura bare.

Legs black; mid tibiae with one anterodorsal bristle; claws and pulvilli elongate; mid femur without comb.

Wings subhyaline; first vein bare, third setulose over halfway to small cross vein; first posterior cell open well before wing tip; costal spine vestigial; calypters white.

Abdomen black, with gray pollen above in a tessellated pattern; basal segments without, third with one pair of median marginal bristles, fourth bearing a marginal row; fifth sternite reddish black, with a wide and deep V-shaped apical incision, inner edge of lobes fringed with black inwardly directed hairs.

Hypopygium black, lightly dusted with gray pollen but moderately shiny in some views; first segment without differentiated bristles on hind margin; second segment globose, clothed with fine longish hairs above; forceps black, curved gently forward, the posterior apical extremity ending in a minute tooth; accessory process red, moderately large, beset with numerous short black hairs near tip; penis not very large, its basal segment translucent white, soft in structure except hind margin which is darker and chitinized; distal segment blackish, subovate in profile, with a median apical claw bowed closely forward between two anterior processes; each of the latter originate at the base of the segment, extend forward to tip of median claw thence rearward tapering to an acute curved tip; posterior claspers rather short and wide at base, tips flattened; anterior claspers longer, strongly bowed, flattened apically and notched on outer side near apex.

Length, 8.5 mm.

Holotype: Male, Great Smoky Mts. Ntl. Pk., Tenn., July 15, 1926 without collector's label.

Sarcophaga elanis, n. sp.

Fig. 12

Male.—Very similar to **S. mendax**, differing mainly in the morphological details of the genitalia. Other minor differences may be listed as follows: Head pollen gray, parafrontals becoming blackish near vertex, which measures 0.21 of head width; cheeks over one-third eye height; thorax rather thinly gray pollinose above and subshiny, pleura more so; prosternum bare; mid tibiae with two anterodorsal bristles; third abdominal segment with marginal row of good-sized bristles; fifth sternite retracted, inner margin of lobes reddish, sparsely black-haired.

Hypopygium wholly black, sprinkled with gray pollen but the surface subshiny in most views; neither segment bristled, sparse fine hairs on first and more abundant coarser ones on second; forceps reddish black on the broad united base, divided and moderately diverging distally, each prong terminating in a small curved tooth; accessory plate red, ordinary in size, moderately hairy; penis with a brown, rather short basal stalk, distal segment moderately swollen, directed forward and divided into two subsegments, the apical one largest, bearing a slender process at the apex which curves over the tip of the copulatory tube and terminates in a delicate pale membrane; both claspers rather stout, directed forward from base, tips flattened and blunt.

Length, 8 mm.

Holotype: Male, "Essex Co., N. Y., June 14, 1924," without collector's label.

Sarcophaga hesterna, n. sp.

Fig. 13

Male.—Exceedingly like **S. acadiana**, but with different hypopygial characters. Other distinguishing items in the present species may be mentioned: Front wider, measuring 0.21 of head width at vertex; hind tibiae rather thickly villose; mid femur without comb; preapical scutellars well developed; fourth abdominal segment wholly black, etc.

Hypopygium not very large; first segment black gray pollinose, with a row of bristles on hind edge; second segment red, subshiny, sparsely haired above; forceps reddish on basal half thence shining brown, divided and moderately divergent distally, as viewed from behind each prong rather thin, bearing a patch of short spinose hairs before apex, latter minutely toothed; accessory process red, with longish hairs on front apical margin; penis rather slender, jointed near middle, basal stalk whitish in front and brown on hind edge; distal segment hardly at all thickened, subovate in profile with the anterior apical extremity deeply emarginate, the median beak small, curved forward and tapering to a thin membrane which overlaps the copulatory tube; shortly in front of latter and arising from within the segment a pair of small and slender processes protrude slightly towards

the front thence curve upward; both claspers rather small, the anterior one decidedly flattened, with broadly rounded tip.

Length, 9.5 mm.

Holotype: Male, "Westport, N.Y., July 12, 1922," no collector's label.

Sarcophaga acadiana, n. sp.

Fig. 14

Allied to **S. sima**, but readily distinguished by obvious differences in structure of the genitalia.

Male.—Vertex 0.18 of head width, front somewhat narrower before ocellar triangle; parafrontals and parafacial gray, the latter with a single row of hairs on outer margin; frontal bristles rather short, in single rows diverging anteriorly with three below antennal base; inner verticals short and stoutish, outer ones absent; ocellars small; antennae black, third segment over twice length of second and reaching lower fourth of face; arista long plumose on basal half or more; vibrissae on oral margin; proboscis short; palpi black, normal in size; cheek gray pollinose, with black hairs, one-third eye height; occiput with three rows of black hairs above and rather abundant pale hairs above the neck becoming sparser below.

Thorax gray pollinose, with three to five black vittae above; anterior acrostichals vestigial; posterior dorsocentrals three; prescutellars missing but the scars large indicating a well developed pair; sternopleurals three; scutellum with two lateral and one decussate apical pair, no preapicals, prosternum and propleura bare; postnotal slopes haired.

Legs black; hind tibiae with rather sparse long hairs on inner edge except near base, middle pair bearing one anterodorsal bristle; middle femur with comb; claws and pulvilli longer than apical tarsal segment.

Wings hyaline; costal spine small; first vein bare, third setulose over halfway to small cross vein; calypters white.

Abdomen with gray tessellated pollen above, black, fourth segment red on hind margin, this color extending forward on median line to basal third of same; segments one and two without median marginals, last two each with a complete marginal row.

Hypopygium wholly red, first segment thinly pale pollinose above, the second more shiny; forceps brownish, rather wide and straight in profile but thin on the divided apical two-fifths as viewed from behind; accessory process red, moderately large, with sparse hairs along front margin; penis rather short, its basal segment blackish behind and pale in front, distal segment subovate in profile with the narrowed median terminal part curved forward between two wider lateral processes, which are strongly incurved as viewed from behind; on each side in front near the base of apical segment is a small white plumose or featherlike appendage closely appressed and hardly visible in lateral view; posterior forceps moderately large, nearly straight tips flattened and rather wide; anterior forceps slightly heavier, directed forward from base, with a lobe on outer side before middle; fifth sternite yellow, divided apically, lobes largely retracted.

Length, 10 mm.

Holotype: Male, Franklin, Louisiana, April 23, 1938 (John Standish).

Sarcophaga fortisa, n. sp.

Fig. 15

Male.—Like the preceding species but closer to **S. sima** in genital features. Fourth abdominal segment and fifth sternite wholly black, lobes of latter with a dense fringe of black hairs on inner margin; hind tibiae with abundant villosity, middle pair bearing two anterodorsal bristles.

Hypopygium moderately large; first segment black, with a row of weak bristly hairs on hind margin; second segment large, globose, subshining red; forceps red basally, rather long, straight and thick in profile ending in a small incurved tooth, divided apically but not divergent in rear view; penis large, its stalk translucent white in front, with chitinized hind margin brown and deeply grooved; distal segment darker, globose, with a rather short median clawlike process extending forward over the hollow anterior side, from within which two pairs of small processes extend forward beyond the lateral rim of the segment (the latter are lacking in **S. sima**); on the front side of the apical segment a heavy process extends downward from the base then divides into two broad diverging arms slightly bowed to the rear; accessory process red, subtriangular, sparsely haired; anterior claspers directed forward from base, flattened and not strongly tapered; posterior claspers shorter, moderately bowed, tips flat, rounded.

Length, 12 mm.

Holotype: Male, Amherst, Ohio, July 14, 1926 (A. J. Barckert).

Sarcophaga mimoris, n. sp.

Fig. 16

A blackish feebly shining species, with three postsutural dorsocentrals; male hind tibiae moderately villose, second genital segment red.

Male.—Front at vertex 0.20 of head width, narrowed a trifle before ocelli thence widening rapidly into facial angle; parafrontals gray becoming darker near vertex; parafacials subsilvery, with minute hairs above and coarser ones below on outer margin; frontal rows moderately diverging anteriorly, two bristles beneath antennal base; ocellars small, inner verticals moderately stout, outer ones barely differentiated; antennae black, third segment about twice length of second and reaching lower fourth of face; arista long plumose to middle or beyond; vibrissae near oral margin; cheeks cinerous, black-haired, a little under one-third eye height; proboscis short; palpi black, stoutish; occiput with three rows of black hairs above and white pile at middle and below.

Thorax gray pollinose, the dark dorsal vittae not very well defined behind suture. Chatetotaxy: acrostichal, 0,1 (prescutellar well developed); dorsocentral 3,3; presutural 1 (outer); humeral 3; sternopleural 3; scutellum with 2 large lateral, 1 small decussate apical and 1 preapical pair; prosternum and postalar slopes setose; propleura bare.

Legs shiny black; mid tibiae with one anterodorsal bristle; mid femur without distinct comb; claws and pulvilli elongate.

Wings gray hyaline; first vein bare, second setulose over halfway to small cross vein; costal spine small but distinct; calypters white.

Abdomen black, with gray tessellated pollen above; first and second segments with only lateral bristles; third with one median marginal and three to five lateral pairs; fourth with a complete marginal row; fifth sternite mostly blackish, widely divided apically, inner edge of lobes fringed with black hairs.

Hypopygium moderately large, first segment grayish black, becoming brownish basally, second shiny red; forceps moderately thick and nearly straight in profile ending in a minute tooth, united nearly to apex as viewed from the rear, the broad flat basal part reddish and clothed with fine recumbent hairs; accessory process red, sparsely black-haired; penis with a rather slender basal stalk, brownish on hind side and translucent white in front; distal segment globose narrowed apically to a gently curved median beak; beginning at the base of the segment in front two processes extend forward, the anterior one small, tapering to a simple sharp tip, the posterior one larger and broadly recurved dorsally on the apex; claspers rather short and stout, anterior pair rather strongly flattened distally, with tips emarginate.

Female.—Like male, comparatively dark and subshiny in general aspect; front at vertex 0.25 of head width and equibroad nearly to antennal base; outer verticals and orbitals present; apical scutellars lacking; abdomen more thinly pollinose and shining above than in male; genital segments red, retracted, without larvipositor.

Length, 6-10 mm.

Holotype: Male, Amherst, Ohio, July 16, 1930 (H. J. Reinhard). Paratypes: 5 males and 1 female, same data as type, except two dated June 5, 1924.

Sarcophaga postilla, n. sp.

Fig. 17

Close to S. cessator, to which it traces in Aldrich's key, but at once distinguished by the different structure of the internal parts of the male genitalia.

Male.—Front at vertex 0.26 of head width and barely narrower before ocelli; parafrontals and parafacials whitish to silvery pollinose, the latter almost as wide as clypeus, with the usual row of hairs on outer margin to middle thence scattered sparsely over most of lower half, none large or bristly; frontal rows sharply divergent anteriorly, two bristles beneath antennal base; outer verticals vestigial; ocellars small; antennae three-fourths length of face, black, second segment reddish on apex and about half as long as third; arista long plumose on basal three-fifths; vibrissae slightly above oral margin; cheeks cinereous, black-haired, nearly two-fifths eye height; proboscis short; palpi normal, black; occiput with three rows of black hairs on upper margin, thence wholly pale-haired downward.

Thorax rather densely gray pollinose, the median vitta above divided

into three narrower ones of which the outer stop shortly behind suture and middle one extends to apex of scutellum; anterior acrostichals two or three; prescutellars well developed; postsutural dorsocentrals three; sternopleurals three; scutellum with two strong lateral, one small decussate apical and one preapical pair; prosternum and postnotal slopes haired; propleura bare.

Legs black, basal segments gray pollinose; hind tibiae moderately villose; mid femur with three or four stubby spines on the ventral posterior edge near apex; mid tibiae with two anterodorsal bristles; claws and pulvilli elongate.

Wings hyaline; costal spine short; first vein bare, third with six to eight hairs extending nearly halfway to small cross vein; calypters white.

Abdomen black, gray pollinose, tessellated, with three somewhat changeable vittae visible in most angles; three basal segments with only lateral bristles, fourth bearing a complete marginal row; fifth sternite red, widely and deeply cleft at middle behind, the lobes small, retracted and fringed with black hairs along each diverging inner margin.

Hypopygium wholly red, rather large; first segment lightly pollinose, with a row of six to eight good-sized bristles on hind margin; second segment globose, moderately bristled and haired above; forceps red on proximal two-thirds, the united basal part behind concave and sloped forward, the free part moderately wide in profile terminating in gently bowed tips; viewed from behind the forceps beyond the basal curvature are divided but contiguous to apical third, from this point basad the inner margin of each prong bears a dense vestiture of pale, pubescent hairs; penis jointed near base only, its stalk rather slender in profile, divided distally into two slender simple-tipped processes which recurve apically enclosing a black soft padlike structure bearing minute stubby spines on the flat upper surface, from the inner extremity of the latter a pair of broad subtriangular processes extend forward and inward, these are shining reddish to brown and chitinized in texture; posterior claspers rather slender, straight, tapering to a sharp tip; anterior claspers very small and inconspicuous.

Length, 10-11 mm.

Holotype: Male, Costa Mesa, California, July 20, 1938 (J. G. Shanafelt). Paratype: 1 male, Oceanside, California, June 24, 1921, no collector's label.

Sarcophaga cosmeta, n. sp.

Fig. 18

A medium-sized, black western species seeming close to **S. sarraceniae**, which I have not seen. The genitalia of the latter, as figured by Aldrich, show distinct differences from the present form.

Male.—Front at vertex 0.21 of head width and a trifle narrower before ocellar triangle; parafrontals and parafacials pale yellowish gray pollinose, the former appearing blackish on upper half in some views; frontal rows strongly divergent anteriorly, two or three bristles beneath antennal base; postocular fringe unusually long above, postocellars well developed; inner verticals long; ocellars small, divaricate, often one or more secondary pairs present; antennae back, third segment rather wide and hardly twice longer

than second, reaching to lower fourth of face; arista moderately long plumose to middle or beyond; epistoma short, bowed forward; vibrissae on oral margin; facial ridges haired to middle; parafacial with the usual row of hairs on outer margin becoming bristly below; proboscis moderately stout, haustellum a little longer than palpi, latter black; cheeks cinereous, moderately clothed with long black hairs, one-third eye height; back of head rather strongly bulged, pale pilose with several irregular rows of coarser black hairs on upper margin.

Thorax gray pollinose with five to seven black vittae above, rather strongly bristled. Chaetotaxy: acrostichal 0,1; dorsocentral 2 or 3,3; presutural 1 (outer); intraalar 2 (none near suture); supraalar 3; sternopleural 3; scutellum with 4 lateral (basal and intermediate one sometimes very weak), 1 good-sized decussate apical and 1 long preapical pair; propleura bare; prosternum and postnotal slopes setose.

Legs black, hind femur with three well developed rows of bristles on outer side, the preceding one without comb; mid tibiae with two anterodorsal bristles; hind tibiae with rather dense long hairs on entire length; claws and pulvilli long.

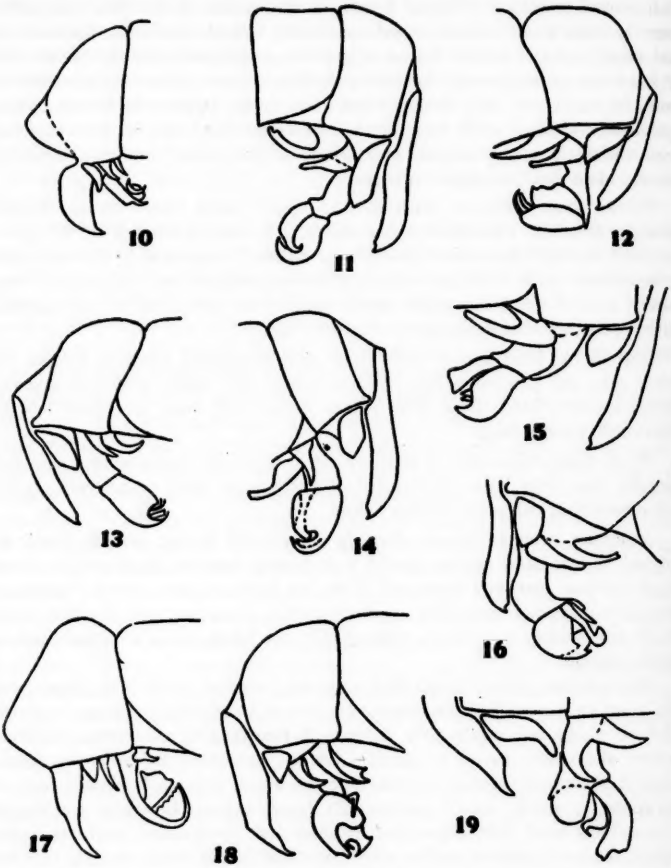
Wings subhyaline with a uniform light brownish shade except on hind margin; first vein bare, third setulose halfway to small cross vein; costal spine vestigial; calypters opaque white.

Abdomen gray pollinose, strongly tessellated above; wholly black in ground color; basal segments with only lateral bristles, third with a strong erect median marginal pair and three or four at side; fourth bearing a complete marginal row; fifth sternite largely retracted, the blackish lobes small and widely separated, with closely set black hairs on basal half of inner margin.

Hypopygium rather large; first segment polished black with hind margin more or less reddish and bearing a row of bristly hairs; second segment globose, shiny red, moderately beset with fine long hairs; forceps blackish, rather short and broad in profile, hardly narrowed to near tip thence sloping obliquely forward to the anterior apical extremity which ends in an acute tip; penis jointed near middle, basal segment brownish and deeply rooved on hind side, somewhat swollen and translucent white in front; apical segment globose with a short terminal apical beak curving forward between two lateral processes which curve back, the tips of latter are expanded and bear minute flat or scalelike hairs; near base and arising from the hollow front side of the segment a pair of small processes extend barely above the rim then turn angularly forward terminating as a delicate pale membrane; anterior clasper directed forward, tortate and concave on inner surface apically with broad tips deeply emarginate; hind forceps smaller, tapering to simple curved tips.

Length, 10-12 mm.

Holotype: Male, Fall City, Washington, June 9, 1932 (J. Wilcox). Paratypes: 2 males, Electron and Olympia, Washington, May 7 and 19, 1935. (J. Wilcox) and 1 male, labeled "Oregon, August 18, 1930."



Lateral View of Male Genitalia

Plate II

Figure 10. **Sarcophaga alopecis, n. sp.**
Figure 11. **Sarcophaga mendax, n. sp.**
Figure 12. **Sarcophaga elanis, n. sp.**
Figure 13. **Sarcophaga hesterna, n. sp.**
Figure 14. **Sarcophaga acadiana, n. sp.**
Figure 15. **Sarcophaga fortisa, n. sp.**
Figure 16. **Sarcophaga mimoris, n. sp.**
Figure 17. **Sarcophaga postilla, n. sp.**
Figure 18. **Sarcophaga cosmeta, n. sp.**
Figure 19. **Sarcophaga litorosa, n. sp.**

One female bearing the same data as the Oregon male, and apparently taken in company with it, may belong here. It has the same dark shiny habitus of the male, but there are only two lateral scutellars present, the middle tibiae bear three anterodorsal bristles, and the apex of the abdomen is red.

Sarcophaga litorosa

Fig. 19

Allied to S. setulosa Wulp (Boettcheria cimbicis Townsend), but the internal parts of the genitalia differ somewhat in structure and the heavy vestiture of long wavy hairs on hind side of forceps in S. setulosa is lacking in the present species.

Male.—Front at vertex 0.23 and at narrowest part (before ocelli) 0.20 of head width; parafrontals and parafacials pale yellowish gray pollinose, the latter with the usual row of hairs but set well in from lateral margin; frontal rows strongly divergent and three or four bristles below antennal base; outer verticals absent; ocellars slender; antennae black, third segment twice length of second and reaching nearly to vibrissae, which are on oral margin; arista with medium length plumosity for three-fifths its length; proboscis short, palpi black, with numerous hairs; cheeks subshining black, with thin gray pollen and long black hairs, one-third eye height; occiput wholly black-haired on upper half and pale pilose at middle below.

Thorax gray pollinose with the usual three to five black vittae above; anterior acrostichals developed, usually three but hind pair sometimes vestigial or absent; prescutellars very small and hairlike, often entirely lacking; three postsutural dorsocentrals (one specimen with four); three sternopleurals; scutellum with three lateral, one long decussate apical and one preapical; propleura bare.

Legs black; hind tibiae with long dense erect hairs, the preceding pair bearing one large and usually one small anterodorsal bristle; hind femur with two complete rows of stout bristles on outer side above middle and a partially developed row on lower edge beyond middle; mid femur without comb; pulvilli large, brownish.

Wings subhyaline, small cross vein slightly infuscated; third vein haired over halfway to small cross vein, first bare; costal spine vestigial; calypters white.

Abdomen rather long and narrow, with gray pollen above in a strongly tessellated pattern; third segment with a pair of stout erect median marginals and three or four laterals; fourth segment with a marginal row; fifth sternite red, bearing a pair of flattened or padlike structures at the base of the V-shaped cleft and immediately beneath these two short pale knoblike processes which are directed downward.

Hypopygium rather large; first segment red with basal half somewhat gibbus above and more or less infuscated, a row of small bristles before hind margin; second segment smaller, without bristles, wholly red; forceps red, short and broad in profile with the anterior edge sloping obliquely rearward narrowing the posterior extremity to a short curved beak; penis

with a short basal stalk, distal segment terminating in a rounded knob behind and bearing a long curved claw in front which divides apically into two diverging prongs, each ending in a soft irregular membrane; between the rounded posterior part of the segment and the base of the anterior claw a pair of small processes extend downward for half the length of claw thence bow rearward with the thin or flattened tips sharply recurved and their basal half concealed by a thin rounded membranous lobe which is not very conspicuous in profile; claspers ordinary, both pairs rather short and stout.

Length, 10-13 mm.

Holotype: Male, Sequoia National Park, California, August 6, 1940 (E. E. Kenaga), in the Snow Entomological Collections, University of Kansas. Paratypes: 14 males from California as follows: Yosemite National Park, August 1, 1940 (R. H. Beamer); Jamesburg, August 11, 1938 (D. W. Craik, Jean Russell); Pacific, August 9, 1940 (L. J. Lipvosky, R. H. Beamer); and Palm City, July 27, 1938 (Jean Russell). Seven males, Puyallup, Washington, May, June and September, 1933 (J. Wilcox).

(To be concluded in October issue.)

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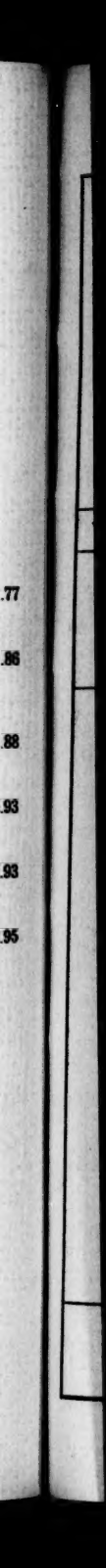
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